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CHAPTER 12

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The Theory of Dispute Resolution with Application to Intellectual Property Rights

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Abstract

We survey several of the theoretical models that have been applied to the analysis of the GATT/WTO dispute settlement process. These include repeated game models, which emphasize the punishment aspect of dispute settlement, and incomplete contracting models, which emphasize the “gap-filling” aspect. Our analysis emphasizes the implications of these models for the strengthening of the dispute settlement process under the WTO and for its application to the TRIPS agreement. We also discuss how models of settlement bargaining can be applied to obtain empirical predictions about which cases will actually proceed to an actual finding by the dispute panel.

Keywords: Trade agreements, WTO dispute settlement, TRIPS

JEL classifications: F13, F53, F55

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1. Introduction

The World Trade Organization (WTO) features a dispute settlement process (DSP) that has come to play a key role in the organization’s trade agreements. A major change in the General Agreement on Tariffs and Trade (GATT) in its transition to the WTO has been the strengthening of the DSP mechanism to make it more likely that rulings of the WTO panels on disputes are carried out in a timely fashion. The new DSP has been actively utilized since its inception in 1995, with more than 350 complaints brought to the WTO by the end of 2006. The effectiveness of the DSP is one of the features that sets the WTO agreements apart from other international agreements. It is often cited as one of the factors permitting the effective inclusion of agreements on intellectual property rights (IPR) as part of the WTO.

This process has not been without its critics. One concern with the DSP is that it still is relatively ineffective at punishing countries that violate their WTO obligations,

even with its recent strengthening. Disputes often carry on for years and defendants can escape having to pay any penalties until the point at which the judgment has been made and the appeals process completed. On the other hand, it has been argued that the flexibility of the system is necessary for countries to be willing to engage in significant trade liberalization. The potential for swift and certain punishment for any country that deviates from a previous promise might cause countries to be more cautious about making significant cuts.

A second concern has to do with the impact of the dispute settlement process on the developing countries. Although participation by developing countries in the system has increased, the costs of bringing a case are disproportionately high for them. The fraction of complaints brought to the WTO by developing countries is smaller than the proportion those countries represent in the WTO, and the least-developed countries have not participated in the process. This suggests that developing countries may be underrepresented in the DSP.

Our objective in this chapter is to provide a review of the theoretical literature on trade agreements as it relates to the settlement of disputes, and to use this literature to address the questions that have been raised about the DSP. In particular, we emphasize the role of the DSP in relation to the WTO's Agreement on trade-related aspects of intellectual property rights (TRIPS). We begin in Section 2 with a brief summary of the main features of the Dispute Settlement Understanding that was negotiated as part of the Uruguay Round. The Uruguay Round also incorporated the TRIPS Agreement, and we discuss some of the issues that are specific to the application of dispute settlement to its subject matter. In Section 3 we provide a benchmark model of an international agreement that resolves a Prisoner's Dilemma between the member countries, and illustrate how this basic model can be used to explain the benefits of international agreements over both tariff rates and IPR protection. In particular, the motivation for bringing together agreements on trade and IPR is discussed.

The Prisoner's-Dilemma model provides a setting in which the role of dispute settlement can be discussed. We highlight two approaches to modeling dispute settlement, repeated-game models and incomplete-contracting models, which illustrate the tension between enforcement and flexibility in trade agreements. Repeated-game models emphasize the requirement that since international agreements lack a third-party enforcer, they must be supported by threats of future trade punishment. The dispute settlement process is a natural venue in which to find this enforcement power. However, the simplest repeated-game models suggest that punishment should be swift and severe, which seems to contradict experience with the WTO process. We discuss how extensions of the repeated-game models have been used to provide explanations of why punishments may be limited.

Incomplete-contracting models, on the other hand, emphasize the fact that there may be states of the world in which the prescribed actions in a trade agreement are not efficient. The incompleteness of the contract is typically thought to arise due to the cost of including terms in the contract to cover all of the possible states that may occur. A potential role for dispute settlement in this case is to make it easier for the parties to obtain an efficient outcome. This approach supports the wisdom of the flexibility

1 of the DSP. We then discuss the extent to which the rules of the WTO process can be
2 interpreted as making it easier to obtain more efficient outcomes.

3 In Section 4 of the paper we analyze the DSP from the point of view of settlement
4 bargaining. The question here is to explain how the rules of the DSP will affect the
5 incentives of the parties to initiate disputes and whether to settle them prior to the panel
6 ruling. These models provide predictions about how the probability of settlement is
7 related to the litigation costs of the parties and the features of the case. In particular,
8 these models can be used to determine whether the observed behavior of developing
9 countries as defendants and plaintiffs is consistent with the hypothesis that they are
10 handicapped by high costs of litigation. Section 5 offers some concluding remarks.
11

12 **2. The WTO dispute settlement procedure and its application to intellectual 13 property**

15 The current operation of the DSP is governed by the dispute settlement understanding
16 (DSU) that was negotiated as part of the 1995 Uruguay Round Agreements that
17 founded the World Trade Organization. Our purpose in this section is to highlight the
18 main features that models of the DSP have sought to explain. We also provide a brief
19 discussion of the specific application of these procedures to disputes under the TRIPS
20 agreement.
21

22 **2.1. The dispute settlement process**

25 Article XXIII of the GATT gave member countries the right to initiate a complaint
26 against another member that had taken actions which “nullified or impaired” the benefits
27 resulting from the agreement. Complaints take one of two forms: a member country
28 has taken actions which are either directly in conflict with its obligations under the
29 WTO agreements (a “violation case”) or a member has taken actions which have the
30 effect of undermining benefits accruing to a member country under the agreements
31 (a “non-violation case”). The DSU encourages countries to resolve the dispute by
32 consultations. If a mutually satisfactory agreement to the issue cannot be reached,
33 then the complaining country can request the formation of a panel of experts to evaluate
34 the complaint. If multiple countries make the same complaint against a member,
35 these complaints are combined and considered by a single panel. Third parties that
36 have an interest in a complaint may provide statements for consideration by the panel.
37

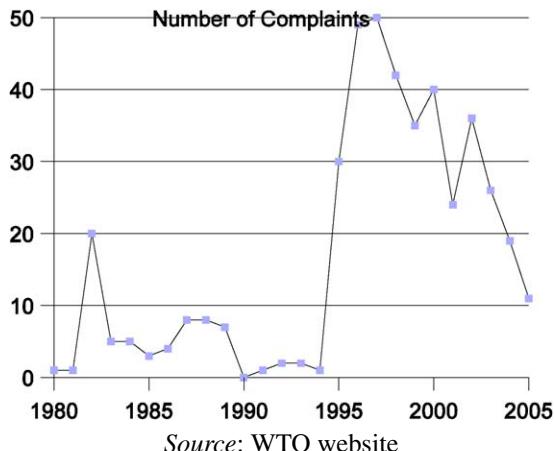
38 The dispute panel evaluates the submissions of the parties for their consistency with
39 the WTO agreements and issues a finding of fact. The report of the panel is similar
40 to the ruling of a court in common-law systems, in that it can cite precedent from
41 previous cases in reaching its decision. In the event that a member is found to have
42 taken measures that violate the agreement, the panel includes a recommendation on
43 how these measures should be altered to bring them into compliance. The respondent
44 has the right to appeal the ruling to a sitting Appellate Body. If the panel report is
approved by the member countries and the respondent fails to comply with the report

1 after a reasonable period of time, the complaining party has the right to compensation
2 in the form of the withdrawal of equivalent concessions. This means that the complain-
3 ing party can suspend its obligations to the respondent in an amount that is equivalent
4 to the amount of nullification or impairment it has suffered. The DSU specifies that
5 compensation is intended to be temporary, in that it will only last until the respondent
6 country's policies are brought into line with its WTO obligations.

7 The DSU involves two major attempts to strengthen the dispute settlement process
8 above the one that had operated earlier under the GATT. The first is the elimination of
9 the requirement of unanimity in order for a panel report to be implemented. Under the
10 GATT process the formation of a panel or the acceptance of a panel report could be
11 blocked by any member, including the defendant. [Srinivasan \(2006\)](#) notes that reports
12 on a number of sensitive cases were blocked in the period 1987–1989, including all
13 five cases brought under the plurilateral subsidies code. In contrast, under the DSU
14 the adoption of the panel report is automatic, unless the members unanimously decide
15 not to adopt the report. The second major change has been the setting of specific time
16 requirements for each stage of the dispute settlement process in order to speed it up.
17 Under the GATT procedure, a case could carry on for as long as a decade. The new
18 WTO procedure attempts to ensure that the process proceeds more quickly by setting
19 specific time limits at each stage. For example, a panel has six months from the time
20 that it is established to complete its report, with a period of nine months being allowed
21 for exceptional cases.

22 In practice, these changes have been a mixed success. With regard to attempts to
23 speed up the process, [Horn and Mavroidis \(2006\)](#) report that these guidelines have
24 not always been met. The average length of time from establishment of a panel to
25 the issuance of its report has been over a year, with 18 of the cases taking more than
26 500 days. Furthermore, [Srinivasan \(2006\)](#) argues that new regulations concerning the
27 timing of negotiations have had the effect of replacing the lengthy pre-trial negotia-
28 tions by lengthy post-trial negotiations and arbitrations. However, the changes have
29 resulted in substantially more usage of the dispute process as illustrated in [Figure 1](#).
30 Under the GATT, there were an average of 4.5 complaints filed per year from 1980 to
31 1994. From the beginning of the WTO process to 2003, an average of 38.7 complaints
32 per year have been filed.

33 To summarize, there are several features of the DSU that stand out. First is the
34 emphasis on getting members to comply with their obligations under the WTO agree-
35 ments, preferably by consultations without having to resort to establishment of a panel.
36 Punishment is to be used only as a last resort, and is intended to last only until the
37 defecting country comes into compliance. In practice, only about 40 percent of the
38 311 complaints brought under the DSU in its first 10 years of operation have reached
39 the stage of having a panel report issued. A second point is that the DSU discourages
40 unilateral actions. Even if a country is certain that a violation has occurred its grievance
41 will not be recognized by the WTO until a finding has been issued by the panel. There-
42 fore, a defendant can respond to such unilateral actions by initiating a counter-dispute
43 against the complaining party. Third, rather than facilitating the imposition of punish-
44 ments against the offending party, the DSU tries to limit retaliation as the outcome of



Source: WTO website

Fig. 1. Complaints under GATT (1980–1994) and WTO dispute settlement process.

disputes among member countries. This reveals an important difference between the conventional court systems and the WTO dispute settlement mechanism. While conventional courts act as external entities for enforcement of contracts, the DSU plays the role of an arbitrator which helps the contracting parties avoid the breakdown of cooperation.

2.2. TRIPS and dispute settlement

Prior to the formation of the WTO, there were international agreements covering a variety of forms of intellectual property. These included the Berne Convention (copyrights), the Paris Convention (patents, trademarks and industrial designs), the Washington Treaty (integrated circuits), and the Hague Agreement (industrial designs). The World Intellectual Property Organization (WIPO) was established by treaty in 1967 and became a specialized agency of the United Nations in 1974. Its essential tasks are to administer these various treaties on intellectual property and to foster cooperation between member states.

The inclusion of the TRIPS Agreement in the WTO had two primary impacts on the protection of intellectual property.¹ The first was to raise the standards for intellectual property protection worldwide, both by strengthening many of the rules governing IPR in existing agreements and by expanding the application of global requirements to all WTO member countries.² For example, a minimum standard of 20

¹ Among the many published descriptions of TRIPS standards and the need for policy reforms, see [Maskus \(2000\)](#).

² TRIPS is a foundational agreement of the WTO and is not within the ambit of WIPO.

1 years for patent life was set and the range of intellectual property covered was ex-
2 panded. In addition to requiring that laws be made consistent with these minimum
3 standards, TRIPS also required countries to have adequate enforcement procedures to
4 allow owners of IPR to take action against infringers. The application of TRIPS to all
5 WTO members required the rewriting of many national laws on IPR protection. These
6 changes were particularly significant for developing countries, many of which had lax
7 or non-existent protection of intellectual property. As a result, developing countries
8 were given a five-year transition period to meet their TRIPS obligations and the least-
9 developed countries were allowed a 10-year transition period.

10 The second important feature of the TRIPS Agreement was the application of the
11 WTO dispute settlement mechanism to disputes involving IPR. Previous agreements
12 either did not specify a dispute settlement mechanism, or had ineffective mechanisms
13 that were not used in practice. The Paris Convention on patents included a provi-
14 sion that allowed disputes to be taken to the International Court of Justice. However,
15 Emmert (1989) notes that a majority of the member states had not recognized the
16 compulsory jurisdiction of the International Court of Justice for patent issues and that,
17 in practice, there were no disputes taken before the Court. Similarly, enforcement is-
18 sues were not seriously addressed in the Berne Convention on copyrights and many
19 thought that protection offered by the majority of members was inadequate. Emmert
20 (1989) summarized the dispute settlement process of these agreements as “effectively
21 worthless.”³

22 In addition to providing a structure for resolving disputes over IPR protection, the
23 linking of TRIPS with the WTO trade agreements offers a more effective means of
24 providing compensation for an injured party in broader trade disputes. On some occa-
25 sions, it will be difficult to identify a means for making adequate compensation based
26 solely on merchandise trade flows. For example, suppose that a complainant country
27 exports to the respondent’s market but imports relatively little from that country. It
28 may be impossible to find tariff concessions that can be suspended by the complaining
29 country to provide adequate compensation. This is particularly true of IPR protection,
30 because many developing countries are primarily importers of technology rather than
31 exporters. If a developed nation were to suspend application of its patent or copyright
32 rules for them there would be little effective impact.

33 The DSU specifies that when choosing compensation, the complainant should first
34 consider concessions that are in the same sector as that in which the injury occurred.
35 If this is impossible, then it may suspend concessions under another sector within the
36 same agreement (e.g., trade in goods under the GATT or commerce in services under
37 the General Agreement on Trade in Services, the GATS). If neither of these options
38 yields appropriate punishment and the circumstances are serious enough, the com-
39 plainant can seek to withdraw concessions under another covered agreement. In the
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42 ³ WIPO has a process for settling disputes over IPR claims between parties from different jurisdictions.
43 However, this process is for private parties, which do not have standing before the WTO and, as such, is not
44 a substitute for the WTO process.

case of a violation of TRIPS, a sector refers to a particular type of intellectual property. This would mean, for example, that a violation of patent law would be compensated first by suspension of obligations having to do with patents. If adequate compensation cannot be found under patent obligations, then compensation on another form of intellectual property (such as copyright) can be proposed. If adequate compensation under TRIPS is not available, then obligations on goods trade could be suspended. Similarly, suspension of TRIPS obligations could be used as compensation for nullification of benefits on goods trade.

In principle, this flexibility in compensation can operate effectively in both directions. First, it can provide a means for countries that export technology to enforce agreements with technology-importing countries by denying them market access for some of their exports of goods. Second, it can provide a means for a small country that imports intellectual property to obtain compensation when it is denied market access by a technology-exporting country. For example, in its dispute regarding the banana-import restrictions of the European Union, Ecuador was ultimately permitted to suspend application of certain components of its copyright regime to EU products, though it chose not to do so.

3. Modeling international agreements on trade and intellectual property

In order to understand the role of dispute settlement, we must begin with a theory of why countries pursue international agreements on trade and IPR.

3.1. Welfare externalities and the Prisoner's Dilemma

Most theories are built around the notion that trade agreements are a means of resolving a Prisoner's Dilemma between countries. In order to allow for the variety of trade and intellectual property policy instruments that can be covered in an international agreement, we illustrate the Prisoner's Dilemma using a two-country model in which the home (foreign) country must each choose a level of a policy instrument $a(a^*)$. The payoffs to the countries will be denoted by $U(a, a^*, s)$ and $U^*(a, a^*, s)$, respectively, where s is a state variable that affects the payoffs to the countries and is assumed to be observable to both of the countries. We provide specific interpretations of these actions and the state variable in terms of tariffs and intellectual property protection below.

The optimal policy choice of the home country is denoted $\tilde{a}(a^*, s)$, which is the home-country action that maximizes its welfare given the foreign policy and the state of the world. The foreign country's optimal policy is similarly denoted $\tilde{a}(a^*, s)$. The Nash-equilibrium policies will be the values $\{a_N(s), a_N^*(s)\}$ that satisfy $a_N = \tilde{a}(a_N^*, s)$ and $a_N^* = \tilde{a}^*(a_N, s)$. Since the Nash-equilibrium policies maximize each country's welfare with respect to its own policy choice, this equilibrium will be inefficient as long as the policy choices of one country affect the welfare of the other. Specifically, if welfare of each country is increasing (decreasing) in the policy choice of the other country, both countries will gain by a mutual increase (decrease) in a in

1 the neighborhood of the Nash equilibrium. Absent this spillover, unilateral policies
 2 will be optimal and there will be no need for a trade agreement.

3 In the case of trade policy, the policy instrument for the home (foreign) country
 4 will be its tariff, $\tau(\tau^*)$. When the home country sets its tariff unilaterally, there are
 5 two forces leading to a positive optimal tariff. First, there is the “terms of trade” effect
 6 due to the fact that the home tariff depresses the price of the imported good when
 7 the home country is large enough to affect world prices. The worsening of the terms
 8 of trade has a negative impact on the rest of the world, so tariffs will be too high in
 9 the Nash equilibrium because of their negative spillover to other countries. This is the
 10 classic argument as to why tariff wars occur, and the implications of this behavior for
 11 welfare in the non-cooperative equilibrium were first examined by Johnson (1953).

12 More recently, emphasis has shifted to introducing a “political economy effect,”
 13 which is that politically powerful interests in the import-competing sector will influ-
 14 ence the government to provide protection against foreign competition. This approach
 15 can help to explain why tariffs might be positive even in countries that are too small to
 16 influence world prices and why tariffs may seem to protect organized interest groups.
 17 Note however that under the political-economy models, the Prisoner’s Dilemma may
 18 remain operative, which leaves room for mutual welfare-improving agreements. The
 19 models of Grossman and Helpman (1995) and Bagwell and Staiger (1999) show that
 20 the terms of trade effects continue to provide a negative spillover to the rest of the
 21 world even when political effects are taken into account. In other words, even under
 22 political-economy models, the use of tariffs features a beggar-thy-neighbor approach
 23 because a country manipulates its trade policy to benefit its residents at the expense of
 24 other societies (Jackson, 2000).

25 A similar Prisoner’s Dilemma applies to agreements involving intellectual prop-
 26 erty as well. In this case we can denote the welfare of the home country as $U(T, T^*)$,
 27 where $T(T^*)$ denotes the strictness of the intellectual property protection chosen by
 28 the home (foreign) country. Protecting intellectual property involves a tradeoff be-
 29 tween the static deadweight loss generated by granting a monopoly to the innovator
 30 against the greater rate of innovation that results when innovations are more profitable.
 31 With diminishing returns to innovation, an optimal degree of patent protection will ex-
 32 ist at which $\partial U(T, T^*) / \partial T = 0$. Two caveats should be added to this argument in an
 33 open economy, as recently shown by Grossman and Lai (2004). One is that each coun-
 34 try’s national loss due to monopoly will be greater when the rights to the innovation
 35 are owned by foreigners. The second is that patent protection in small countries might
 36 have minimal national benefits, since the additional profits earned by innovators in
 37 that market might be such a small share of worldwide profits that they would have
 38 little impact on the world rate of innovation. As a result, countries that are primarily
 39 importers of intellectual property or countries with small markets might have little or
 40 no incentive to protect intellectual property absent an international agreement.⁴

43 ⁴ Bond (2005) provides examples of early national laws that failed to provide national treatment to foreign-
 44 ers in the protection and enforcement of intellectual property rights, and also examples of how the strictness

An increase in foreign patent protection will have a favorable spillover to the home market, because it will lead to higher profits for home innovators that sell in the foreign market and will also raise the rate of innovation. Since the spillovers to overseas markets are not considered by countries in setting their patent policy, an agreement that expands protection in both countries in the neighborhood of the Nash-equilibrium level will yield a welfare improvement for both countries. Thus, the Prisoner's Dilemma also provides an argument for international agreements to strengthen protection of intellectual property. It should be noted here that although the theory predicts benefits from mutual expansion of intellectual property protection, it does not guarantee that a harmonization of IPR rules will benefit all countries. In particular, small countries and countries that are primarily importers of intellectual property would expect to receive little benefit from agreements that required a substantial increase in their degree of protection. This would suggest that one of the main reasons for the inclusion of TRIPS in the WTO was to provide a way of inducing developing countries to adopt more stringent protection of intellectual property by trading concessions on market access, as argued in Bond (2005). For example, Helpel (2004) notes that “[d]eveloping nations agreed to include intellectual property within the newly created WTO in exchange for securing access to the markets of industrialized states for their agricultural products, textiles, and other goods.”⁵

The above discussion identified the sources of gain from international agreements. An international agreement would be an efficient contract if it specified Pareto-efficient actions $\{a(s), a^*(s)\}$ to be taken by each of the countries in each of the relevant states of the world.⁶ However, there are two problems with designing such contracts. The first is that since the action specified for each country is not a best response to the policy assigned to the other country, countries have an incentive to choose a different policy than the one specified under the agreement. Therefore, some form of enforcement is required to ensure compliance of all parties to the contract. The second is that if the number of potential states of the world is extremely large, then it may be too costly to write a contract that specifies the complete set of state-contingent actions. In this case the specification of actions will be incomplete and it will be necessary to identify what is intended if a set of circumstances occurs for which actions have not been anticipated.

of national laws was linked to the country's market size and whether it was an importer or exporter of IPR. These examples are consistent with the argument that a country's policy on IPR will be influenced by its terms of trade, since granting property rights to foreigners will raise the price of imported goods that enjoy protection.

⁵ Such agreements could also be achieved if there were direct cash transfers from the technology-exporting countries to the importing countries in order to compensate them for extending and enforcing protection of intellectual property agreements. However, it seems more common for countries to trade concessions on different issues rather than to make outright transfers.

⁶ In the case of trade policy, the state-contingent actions might include safeguard protections that allow for alterations in the tariff that arise in the presence of an import surge which might fuel protectionist pressure. For intellectual property, the ability to issue compulsory licenses of pharmaceuticals in the event of a national emergency might be thought of as a state-contingent policy.

Within a particular country the role of enforcing and interpreting contracts typically is handled by courts that have the power to impose judgments on the parties in the event of a dispute. However, such an external enforcement agent is typically lacking in international agreements between sovereign governments. WTO obligations do not have the force of domestic law for many countries (e.g., the United States), so domestic courts would not automatically prohibit actions that violated such commitments. International courts could potentially rule on such disputes but do not have the jurisdiction to impose penalties. Within the WTO the primary threat against a country is the loss of future benefits under its trade agreements if it does not comply. For example, the notion of using threats of retaliatory tariffs to enforce trade agreements has been formalized using the theory of repeated games.

3.2. Enforcement of complete agreements with repeated interactions

The theory of repeated games has shown how cooperative agreements that yield payoffs that Pareto-dominate the Nash-equilibrium payoffs for both countries can be sustained using history-dependent strategies. An example of this is a trigger strategy, in which a deviation by either country triggers a reversion to a punishment phase that specifies actions a_P and a_P^* to be taken by the countries. Since we are focusing on complete contracts that specify actions for all states of nature in this section, we simplify the presentation by assuming that there is a single state. Therefore, s will be suppressed in specifying actions and punishments.

During the punishment phase, the home country receives a payoff $U_P \equiv U(a_P, a_P^*) < U(a, a^*)$ and the foreign country receives $U_P^* \equiv U^*(a_P, a_P^*) < U^*(a, a^*)$. Letting $\delta < 1$ denote the discount on payoffs received in the next period and assuming for simplicity that this punishment lasts forever, a deviating country will receive a discounted payoff of $U(\tilde{a}(a^*), a^*) + \delta U_P / (1 - \delta)$. In order for the punishment to be an effective deterrent, it is necessary that it be credible in the sense that a deviating party would expect the punishment actions (a_P, a_P^*) to be actually carried out by all parties in the event of a deviation. Formally, this requires that the punishment payoff represents an equilibrium to the repeated game beginning at the time following a deviation. A commonly used assumption is that the punishment involves a return to the pre-agreement trade war between the countries, which is credible because it is a Nash equilibrium of the one-shot game.

The agreement will then be self-enforcing for the home country if it satisfies

$$U(a, a^*) \geq (1 - \delta)U(\tilde{a}(a^*), a^*) + \delta U_P. \quad (1)$$

A similar requirement applies to the foreign country. Since $U(\tilde{a}(a^*), a^*) > U(a, a^*) > U_P$, condition (1) will be satisfied for δ sufficiently close to 1. Let $A(\delta, U_P, U_P^*)$ denote the set of agreements (a, a^*) for which (1) is satisfied given the discount factor and punishments. Any of the agreements in this set represents an equilibrium to the repeated game. This multiplicity of equilibria provides a theoretical role for the institutions of the WTO, for that organization can be thought of as designing a set of

1 rules by which countries choose an agreement from the sustainable set $A(\delta, U_P, U_P^*)$.
 2 Presumably this would call for the WTO to design an efficient bargaining protocol,
 3 so that the agreement chosen is not Pareto-dominated within the set of enforceable
 4 agreements.⁷

5 Kovenock and Thursby (1992) provide a stronger role for international trade agree-
 6 ments by assuming that a violation of a commitment made results in an additional cost
 7 being imposed because of the terms of an additional international obligation. They as-
 8 sume that this cost, which may be either a fixed cost or a per-period cost, results any
 9 time a country violates an agreement or the prescribed behavior during a punishment
 10 phase. They show that this additional international obligation cost makes agreements
 11 easier to sustain, but still may not allow countries to sustain free trade.

12 If one adopts the interpretation of the WTO as providing a coordinating mechanism
 13 for playing the repeated game, then one might also expect the WTO to choose its rules
 14 to make the set A as large as possible. For example, it is clear from Equation (1)
 15 that the set A will be non-decreasing in the value of δ , because a larger δ makes an
 16 agreement easier to sustain by putting greater weight on the punishment phase. The
 17 WTO can increase δ by reducing the time span, T , between initiation of a dispute
 18 and imposition of necessary punishments. To see this, note that $\delta = e^{-rT}$, where
 19 r is the market rate of interest. In fact, δ can be interpreted either as a measure of
 20 patience of the contracting parties or the speed with which they can detect and penalize
 21 deviations. Obviously, δ is decreasing in the length of time it takes a dispute panel to
 22 issue a report and to approve punishment against the deviator. The evidence based
 23 on experience seems mixed on this point. Since δ is decreasing in T , efforts by the
 24 WTO to accelerate the dispute settlement process should expand the set of sustainable
 25 agreements. However, the WTO requirement that countries wait until the dispute panel
 26 has ruled, rather than engaging rapidly in unilateral punishments, seems to conflict
 27 with this logic. In the case of a clear violation, it would seem that countries could
 28 adjust tariffs to punish deviators (e.g., by executive order in the United States) much
 29 more rapidly than could be accomplished by waiting for a complaint to work its way
 30 through the dispute process.

31 A second way for the WTO to influence the size of the set of sustainable agreements
 32 is through its choice of punishment levels. The lower the payoff received during the
 33 punishment phase (and the longer the period of the punishment), the larger will be the
 34 set of sustainable agreements. In general-equilibrium trade models there are typically
 35 two Nash equilibria: an interior Nash equilibrium with positive tariffs and trade flows
 36 and an autarkic Nash equilibrium with arbitrarily large tariffs imposed by each coun-
 37 try. An infinite repetition of the latter outcome would be the worst sub-game perfect

38
 39
 40 ⁷ Suppose that there are multiple states and that these are observable to the players so that specified ac-
 41 tions can be state-contingent. In this case the no-deviation constraint will require that the future payoffs be
 42 expectations taken over the possible future states. This case is developed by Bagwell and Staiger (1990) for
 43 the case of symmetric countries where free trade is the Pareto-efficient outcome in all states. They show that
 44 the best sustainable agreement may involve contingent protection, where free trade is sustainable in some
 states but not in others.

1 Nash equilibrium. Thus, it should be the punishment chosen by an institution that is
2 trying to support the largest set of trade agreements. However, clearly this prediction
3 does not characterize the punishments prescribed in the DSU, since the general reluc-
4 tance to punish deviators and the modest nature of the punishments available, such
5 as withdrawal of equivalent concessions, are not consistent with the severest possible
6 punishments.

7 Two approaches have been used to explain why the punishments of the dispute
8 settlement mechanism are so mild when theory would predict strong punishments. One
9 explanation arises from the possibility of renegotiation by the parties once a deviation
10 has occurred. The repeated-game structure implicitly assumes that the parties choose
11 strategies at the beginning of the game, and then mechanically follow them as the
12 game unfolds. However, there is a certain implausibility to the assumption that the
13 punishment could involve an infinite reversion to the autarkic Nash equilibrium if the
14 parties can communicate. Once the punishment phase is underway, there will exist
15 agreements that would leave both countries better off than they are during that phase.
16 Thus, one would expect the countries to engage in renegotiation during the punishment
17 phase.

18 This problem suggests that self-sustaining agreements need to render unnecessary
19 the possibility of renegotiation. [Ludema \(2001\)](#) examines the types of punishments
20 that are renegotiation-proof using a definition of that concept (due to [Pearce, 1987](#)),
21 which requires that the punishment path be sub-game perfect and involve no pun-
22 ishment worse than itself. He shows that the renegotiation-proof punishment path
23 involves play of the interior Nash equilibrium for a finite number of periods, followed
24 by a return to the best supportable equilibrium. This punishment is less severe than the
25 most severe sub-game-perfect punishment, which would be infinite reversion to the
26 autarkic equilibrium.

27 [Klimenko et al. \(2006\)](#) obtain a more pessimistic conclusion about the ability of
28 countries to use trigger strategies to sustain cooperation. They assume that the parties
29 to the agreement meet each period and bargain over the set of feasible trade agreements
30 using the Nash bargaining solution. With this bargaining framework no cooperation
31 can be supported, because the unique equilibrium is the infinite repetition of the static
32 Nash equilibrium. The reason is that since negotiations are repeated each period, the
33 bargaining problem looks the same each time and it is not possible for the outcome
34 to depend on the history of the bargaining game. However, an external entity, such
35 as the WTO, can promote cooperation by labeling the history of the relationship as
36 “cooperate” or “dispute.” This labeling ensures that the parties cannot jointly ignore a
37 violation when it occurs. In their formulation, the role of international trade institutions
38 is to change the initial conditions of the bargaining game at each period, based on the
39 history of the relationship.

40 A second approach to explaining the mild sanctions of the dispute settlement mech-
41 anism is to argue that the WTO contains two types of punishment mechanisms corre-
42 sponding to two different types of deviations. In the first type of deviation, a country
43 abrogates most or all of its trade obligations at once. Although deviations of this type
44 are not explicitly discussed in the WTO agreements, it is understood by members that

such a deviation would result in the breakdown of multilateralism and a return to a trade-war equilibrium. The threat of the breakdown of the system deters such deviations, but since this harsh punishment is an effective deterrent it is never actually observed as long as the system is an equilibrium.

In the second type of deviation, a country defects from some aspect of its obligations without intending to withdraw from the agreement. It is these small deviations that are handled by the WTO's dispute settlement mechanism.⁸ One appeal of this approach is that it highlights the fact that the disputes handled by the WTO do not seem to have the features of cases in which a country deviates on all of its obligations at once.

Zissimos (2007) shows that the idea of having different types of punishments for different magnitudes of deviations can be used to explain why, historically, tariff reductions negotiated at the GATT and WTO have been gradual. He assumes that the contracting parties face a two-part punishment mechanism. If the deviation of one party from the original agreement is considered moderate or "non-abusive" it will be punished by withdrawal of equivalent concessions, whereas a large or "abusive" deviation will face punitive punishments through reversion to Nash equilibrium. He interprets an abusive deviation as one that is sufficiently large that it exceeds the previous period's tariff binding. On the other hand, breaking the current period's promised binding is assumed to be non-abusive and results in the withdrawal of equivalent concessions. With this punishment scheme, an immediate reduction of tariffs to the neighborhood of free trade is not sustainable because even relatively large deviations (i.e., anything less than a reversion to the initial one-shot Nash equilibrium tariffs) would be met only by modest punishment. However, low tariffs will be sustainable once the previous period's binding has become sufficiently low, and free trade will be reached asymptotically.

To summarize, the emphasis in repeated-game models is on the effectiveness of threats of retaliation in preventing countries from renegeing on promises made under a trade agreement. The DSU is a natural place to study the enforcement issue, because it explicitly links the withdrawal of concessions to violations of obligations.

An important common feature of these repeated-game models is that the punishments are set in such a way that the countries never actually deviate from the agreement. This behavior is common to both models with severe punishments and to models where punishments are restricted either by renegotiation or the withdrawal of equivalent concessions.⁹ However, the examples of disputes mentioned earlier illustrate that in practice countries choose policies that violate WTO agreements, suggesting that these models miss an important feature of trade policy.

⁸ Bagwell and Staiger (2002) describe the former as "off the equilibrium path" deviations and the latter as "on the path" deviations.

⁹ Riezman (1991) considers a model in which countries have private information about shocks, but punishments can only be imposed based on publicly observable information. In this case punishments will occur in some states of the world, but countries will never actually deviate from their prescribed strategies.

1 **3.3. Incomplete-contracting models**

2
 3 Contractual incompleteness arises when the contract does not specify a complete set
 4 of policy actions for each state of the world. The WTO agreement is clearly an in-
 5 complete contract. One obvious form of incompleteness is that it places fairly limited
 6 restrictions on a government's use of domestic policy instruments, even though they
 7 could be used to influence the volume of trade. Since tax policies, competition poli-
 8 cies, and environmental policies affect domestic relative prices, they can potentially
 9 be used to alter the volume of trade or to reverse the effects of promises made on
 10 trade liberalization. A second form of incompleteness arises because there is limited
 11 flexibility to change the level of negotiated trade policies in response to changes in
 12 the economic environment. For example, tariffs are bound from above and cannot be
 13 raised beyond those bindings in response to a domestic recession.

14 If contracting is costless, then a contract will specify efficient actions $\{a(s), a^*(s)\}$
 15 in each state s . When contracting is costly, however, it may be inefficient to describe
 16 actions that will be carried out in states that have low probability or are particularly
 17 difficult to describe. Therefore, contracting parties may prefer to write general, rather
 18 than detailed, terms regarding those states or simply ignore them, implying that the
 19 action specified for a particular state, s' , may not be Pareto-efficient. If state s' occurs,
 20 there will exist actions for the countries that Pareto-dominate the action specified in
 21 the contract. It would be desirable in this state to let the countries renegotiate their
 22 actions, since one party can gain by deviating from the action specified in the contract
 23 even after compensating the other party for the deviation. This is referred to in the
 24 legal literature as an "efficient breach" of the contract, for it makes one country better
 25 off but leaves the other whole. One way to allow for efficient breaches is to adopt a
 26 compensation standard that requires the deviating party to be liable for any damages
 27 imposed on the other party to the contract.¹⁰

28 Ethier (2001a, 2001b) argues that the dispute settlement process is a means of in-
 29 jecting desired flexibility into a contract in the presence of contractual incompleteness.
 30 He considers a scenario in which, prior to the signing of a contract, each of the coun-
 31 tries recognizes that there is a possibility of a shock that will cause that party to
 32 choose a domestic policy action that has a negative spillover on the trading partner.
 33 He shows that if the countries choose contractual terms *ex ante*, there are circum-
 34 stances in which it is optimal to have an agreement in which punishment takes the
 35 form of the withdrawal of equivalent concessions and that the deviating country will
 36 choose to accept the punishment rather than reverse its policy. This result is analogous
 37 to the notion of efficient breach, since the parties are better off *ex ante* by allowing
 38 the deviating country to violate the agreement while compensating the injured
 39 party.

40
 41
 42
 43 ¹⁰ This contrasts with a specific performance standard, which would require the deviating party to carry out
 44 the actions specified in the contract.

1 Horn *et al.* (2006) also adopt an incomplete-contracting approach, although their
2 emphasis is slightly different. They study types of government actions and states of the
3 world that should be specified in a contract when contracting costs are related to both
4 the number of states included in the agreement and the number of policy instruments it
5 restricts. The potential policy instruments are both tariffs and domestic policies, such
6 as production and consumption taxes, while there is a domestic consumption external-
7 ity. If contracting were costless, an efficient agreement would equate producer prices
8 in the two countries and use domestic policies to deal with the consumption external-
9 ity. The emphasis in their results is on the interaction between discretion and rigidity
10 in the optimal contract when contracting is costly. Rigidity refers to economizing on
11 contracting costs by setting the same value of an included policy instrument for all
12 states, whereas discretion refers to economizing by leaving a policy instrument out of
13 an agreement. Discretion on a policy instrument allows a government to react to states
14 that are not specified in the contract, but this discretion might also allow a government
15 to indirectly undo restrictions imposed by the contract.

16 In their model, the Prisoner's Dilemma between countries is driven by terms of
17 trade externalities. The benefits of the agreement arise from restrictions on the use
18 of policies that influence the terms of trade. Therefore, an agreement that restricts
19 only domestic policies cannot be optimal because it is ineffective in dealing with the
20 terms of trade problem. When contracting is costly, parties should focus on restrict-
21 ing policies with larger influence on the terms of trade and leave other policies to
22 the discretion of individual governments. They also show that rigidity and discretion
23 tend to be complements in the agreement when there is uncertainty about the level
24 of the consumption externality, since the government needs to use its domestic policy
25 instruments to respond to shocks to that level. However, rigidity and discretion are
26 substitutes when shocks are to the level of demand (and hence trade volumes).

27 This analysis implicitly assumes that the contract is enforced as written, so no room
28 is allowed for the DSP to assist in the adjustment of contract terms in states where
29 the existing terms are not efficient. An alternative means of introducing flexibility
30 into contracts without requiring an enumeration of all states is to tie contract adjust-
31 ments to the outcomes of certain key variables. For example, the escape clause in trade
32 agreements allows for temporary tariff protection in cases where trade liberalization
33 results in substantial harm to the domestic industry. Contract incompleteness may im-
34 ply a "gap-filling" role for the courts. Thus, when a dispute arises in an unspecified
35 contingency, the court may provide an interpretation of the contract that sets out an
36 efficient course of action to be taken by the parties. In a discussion of partnership con-
37 tracts with contractual incompleteness, Shavell (2006) argues that there is an optimal
38 method for interpreting agreements that will yield higher expected social welfare than
39 can be obtained by enforcing them as literally written. If the court employs efficient
40 interpretation rules, the parties will find it unnecessary *ex ante* to specify actions in
41 as many states of the world. Therefore, the prospect of optimal interpretation by the
42 court allows parties to conserve costs by writing simpler contracts. This would sug-
43 gest that DSU guidelines might be set so as to enhance the efficiency of market-access
44 negotiations.

1 **3.4. Enforcement, flexibility and TRIPS**

2
3 The repeated-game approach to describing the WTO emphasizes the enforcement role
4 of the DSP, whereas the incomplete-contracting approach emphasizes the potential for
5 flexibility. We conclude our discussion of these approaches by examining some of the
6 evidence from IPR-related disputes and the potential role for the DSP to introduce
7 flexibility into the WTO agreements.

8 Positions taken by the proponents of TRIPS in the negotiations during the Uruguay
9 Round seem consistent with a significant enforcement role for the DSP. Furthermore,
10 the experience with TRIPS supports the effectiveness of threats of trade retaliation.
11 The dispute cases brought before the WTO involving IPR have focused almost ex-
12 clusively on the incompatibility of national laws with the requirements of the TRIPS
13 agreement. The U.S. case against Denmark was fairly typical.¹¹ The U.S. complaint
14 was that Denmark's law failed to satisfy its TRIPS obligations because it did not al-
15 low for provisional measures in civil litigation involving IPR. The case was resolved
16 by mutual agreement, with Danish law being changed to allow provisional measures.
17 There has been only one case, also settled by consultations, involving the failure of a
18 country to enforce its intellectual property laws.¹² Overall, 13 of the 25 IPR-related
19 cases filed under the dispute settlement procedure were resolved by mutual agree-
20 ment. Nine of the cases resulted in panel reports being filed, with three of those being
21 appealed.

22 For TRIPS cases, contractual incompleteness has (at least so far) seemed to play
23 a less significant role as a source of disputes. The case that might best be interpreted
24 as being about contractual incompleteness is the "bars and grills" case, in which the
25 European Union challenged a U.S. law granting exemptions from paying royalties on
26 music that was played in public places (restaurants, bars, and retail outlets) if the es-
27 tablishments met a certain maximum size requirement.¹³ The EU successfully argued
28 to the panel that this exemption violated the TRIPS agreement because it was too
29 broad and covered more than 70 percent of the restaurants and nearly half of the retail
30 establishments in the United States. The issue in this case was the interpretation of the
31 meaning of exemptions for "special circumstances" that are allowed under TRIPS. Af-
32 ter the United States failed to change its law on this point within a reasonable period of
33 time, the EU was granted compensation. Compensation was made by a cash payment
34 from the United States to the EU, which marked the first time in which a cash payment

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37 ¹¹ Denmark – Measures Affecting the Enforcement of Intellectual Property Rights (DS 83), mutually
38 agreed solution issued 13 June 2001.

39
40 ¹² Greece – Enforcement of Intellectual Property Rights for Motion Pictures and Television Programs
41 (DS-125, Complainant: United States). Television stations in Greece were broadcasting movies without
42 authorization of copyright holders, and the complaint asserted that remedies to copyright holders were not
43 being provided or enforced. A mutually agreed solution was reached that involved additional legislation to
44 enhance enforcement and actions that resulted in the closure of four offending television stations. See also
DS-124.

45
46 ¹³ United States – Section 110(5) of the U.S. Copyright Act (DS-160), panel report adopted 27 July 2000.

1 was made as compensation in a WTO case. Specifically, the United States agreed to
2 pay \$3.3 million as compensation for the lost royalties of European music-rights hold-
3 ers during the three-year period 1996–1998. In return, the EU agreed to withdraw its
4 petition temporarily. However, such monetary compensation is not a common practice
5 in the WTO to this point in time.

6 The analysis of incomplete contracts raised the question of whether the DSU al-
7 lowed a country to adjust its policy to a more efficient one by paying compensation to
8 the injured country. The first point to note is that the DSU encourages countries to
9 find a mutually agreed solution through negotiations. Article 2 (7) of the DSU states
10 that “A mutually acceptable solution that is agreeable to the parties and is consis-
11 tent with the covered agreements is clearly to be preferred.” This would indicate that
12 the agreement encourages the negotiation of *ex post* Pareto-improving adjustments in
13 the agreement, which is consistent with the notion of allowing an efficient breach.
14 However, these negotiated adjustments must still satisfy the basic principles of the
15 agreement. This would preclude the countries from negotiating an adjustment that in-
16 volved the use of voluntary export restraints, which are now prohibited by the WTO.
17 Furthermore, the next sentence in the agreement indicates that “[i]n the absence of a
18 mutually agreed solution, the first objective of the dispute settlement process is usually
19 to secure the withdrawal of the measures concerned if they are found to be inconsistent
20 with any provisions of any of the covered agreements. The provision of compensation
21 should be resorted to only if the immediate withdrawal of the measure is impracticable
22 and as a temporary measure pending the withdrawal of the measure that is inconsistent
23 with the covered agreements.” This language suggests that the objective of the dispute
24 panel should be to ensure that the parties carry out their obligations as outlined in the
25 agreement, which would suggest a specific performance standard.

26 Although a withdrawal of equivalent concessions is allowed as compensation, the
27 emphasis on the use of compensation as a last resort and its temporary nature would
28 suggest that the intention is not to allow countries to purchase relief from obligations
29 under the agreement. In practice there have been very few cases in which monetary
30 compensation has been awarded. The bars and grills case is one of the few cases in
31 which compensation has actually been paid by a country. In a number of cases the
32 granting of the compensation has spurred the defendant country to change its policies
33 to be in compliance with the WTO agreement.

35 **3.5. Multilateralism and the WTO**

36 The models discussed above focused on trade relations between two countries. These
37 two-country models are useful for simplifying the problem, but omit interesting issues
38 that arise in a multilateral setting. One such issue is the possibility of bilateral trade
39 imbalance. If two countries have a bilateral trade imbalance, the principle of reciprocity
40 in trade concessions would prevent them from attaining negotiated free trade.
41 Under this situation, a multilateral trading system may provide proper incentives for
42 further trade liberalization. Maggi (1999) analyzes a three-country model of a tariff

1 game with bilateral trade imbalances but a multilateral balanced trade. He shows that
2 under bilateral trade imbalance, threat of a multilateral punishment leads to higher lev-
3 els of cooperation. The idea is as follows: in an extreme case, suppose that country A
4 only imports from B and only exports to C, and C only exports to B and only imports
5 from A. Then bilateral punishments are impossible and, therefore, multilateral pun-
6 ishments become necessary to deter deviation. According to this framework, the role
7 of the multilateral trading system is to detect violations of the agreements in bilateral
8 relationships and to authorize interested third parties to impose sanctions against the
9 offending party.¹⁴

10 Even though Maggi (1999) suggests a plausible role for a multilateral trade insti-
11 tution, his framework does not represent the reality of the WTO. The DSU does not
12 recognize the right of third parties to impose sanctions against an offending country
13 unless this third country is also adversely affected by the same policy that is the subject
14 of the original dispute. In practice, however, multilateralism may have been instrumen-
15 tal in enforcing the trade agreement in a more subtle way. Davis (2006) compares two
16 dispute cases under different institutional settings to show that the WTO dispute set-
17 tlement process can help developing countries by means of legal “band-wagoning.”
18 The first case is a complaint by Vietnam, accusing the United States of violating its
19 obligation under a bilateral treaty the two countries had reached. Specifically, Viet-
20 nam attempted to prevent the United States from issuing food-labeling requirements
21 that would have excluded its catfish from the U.S. market. Since Vietnam was not
22 a member of the WTO, the dispute was pursued outside that organization’s dispute
23 settlement process. The second case is a WTO dispute in which Peru, along with the
24 United States and Canada, was a complainant against food-labeling regulations issued
25 by the EU that would have limited access to its scallops and sardines.¹⁵ Davis points
26 out that both Peru and Vietnam were disadvantaged because of their lack of retalia-
27 tion power and legal resources. However Peru was far more successful in inducing
28 compliance by the offending party. Peru’s success can be attributed to the presence
29 of Canada and the United States, two countries with substantial retaliation power and
30 legal resources, as joint complainants. Vietnam did not have such advantages in its
31 bilateral relationship with the United States and was unsuccessful in its suit.

32 A related problem concerns the ability of small and developing countries to obtain
33 adequate compensation in the event that they are injured by policies of large devel-
34 oped countries. This can be most easily seen in the case where the small country is
35 effectively a price taker. If the large country imposes a tariff on imports from the small
36 country, the terms of trade for the latter will be worsened proportionally. If the large
37 country refuses to remove the barrier in response to a panel finding, the imposition of
38 a retaliatory tariff by the small nation would have no impact on the terms of trade of
39

40
41 ¹⁴ Third parties may be interested in limiting the market access of the offending party because of the
42 standard beggar-thy-neighbor nature of trade policies.
43
44

45 European Communities – Trade Description of Scallops (DS 12), mutually agreed solution circulated 19
46 July 1996.

1 the former. Instead, it would only further reduce the small nation's welfare. This problem
2 could be resolved if the large country were to pay compensation in the form of
3 a cash transfer. However, such transfers are typically not observed in resolving trade
4 disputes.¹⁶

5 The inclusion of the TRIPS agreement in the WTO may somewhat alleviate this
6 problem, as the suspension of the small country's TRIPS obligations to the offending
7 nation would be a credible and effective punishment. The reason lies in the nature of
8 intellectual property. Consider, for example, the request by Ecuador to suspend certain
9 copyrights for EU performers and producers of recorded music and broadcasts
10 as retaliation in the banana dispute.¹⁷ The discriminatory removal of exclusive copy-
11 rights, for example, could make legal the wholesale copying of EU-issued music and
12 software, a potentially far larger market-access problem than would be tariff retaliation
13 in goods. Ecuador also requested approval to suspend aspects of protection for
14 geographical indications, an element of particular concern for EU food exporters.

16 **3.6. Commitment models of trade agreements**

18 The analysis in this section has been based on the assumption that trade agreements
19 are intended to resolve a Prisoner's Dilemma. Another proposed approach is based on
20 the idea that trade agreements commit governments to permanent trade liberalization
21 in the presence of pressure from domestic interest groups to retain high protection.
22 An example is the model by Maggi and Rodriguez-Clare (1998), in which politicians
23 know that domestic firms in the import-competing sector will lobby for protection in
24 the future. By committing to a trade agreement, they prevent these interest groups
25 from forming and demanding trade barriers. They show that this type of commitment
26 is most valuable for weak governments that are able to extract little surplus from the
27 interest groups in the bargaining over tariffs.

28 In the commitment approach, the DSP would have a slightly different role to play.
29 A decision by the dispute settlement body can be used by the government to deflect
30 political pressure in nations where powerful interest groups demand protection. Under
31 this interpretation, the government might be willing to temporarily erect trade barriers
32 in response to political pressure, but would use the authority of the dispute panel to
33 justify eliminating the restrictions once the panel had ruled.

35 **4. Economic models of litigation and settlement bargaining**

37 We now turn to an analysis of the behavior of countries involved in trade disputes. One
38 of the stated goals of the DSU is to encourage the settlement of trade disputes through

40
41 ¹⁶ Mexico has proposed that retaliation rights be made transferable to third parties as another means of
42 dealing with this problem. Bagwell *et al.* (2004) analyze this issue and point out both benefits and costs of
43 such an amendment.

44 ¹⁷ European Communities – Regime for the Importation, Sale, and Distribution of Bananas (DS 27), mutually agreed solution notified 2 July 2001.

1 consultations, with dispute panels being utilized as a last resort when consultations
 2 fail. Engaging in the dispute settlement process can be quite costly, since attorney
 3 fees for the panel stage can easily reach \$200,000 to \$300,000 for a simple case. For
 4 complicated cases, costs have exceeded \$10 million.¹⁸ The main incentive to settle
 5 the dispute is to avoid the costs of litigation.¹⁹ The demands of the parties during
 6 the settlement negotiations will be influenced by expectations about the outcome if
 7 the case goes to a panel. Thus, the rules of the dispute process will influence the
 8 distribution of gains between the parties from the settlement, as well as the incentive
 9 to file complaints.

10 In this section we start with a formal representation of the settlement-bargaining
 11 process. Then we will discuss several sources of inefficiency – including asymmetric
 12 information among parties, political restrictions, and the like – and identify the char-
 13 acteristics of the parties or the dispute itself that may influence the outcome of the
 14 process. Finally we draw on settlement-bargaining models to explain empirical obser-
 15 vations regarding the behavior of developing and developed countries in the DSP.

18 **4.1. The settlement-negotiation problem defined**

20 To illustrate the settlement negotiation problem, suppose we have an action pair $a^0 =$
 21 (a_c^0, a_d^0) reflecting the initial policy choices of the complainant (a_c) and defendant (a_d)
 22 at the time the complaint is made. The payoffs to the complainant and defendant from
 23 this policy pair are denoted W_c^0 and W_d^0 , respectively. Let a^1 denote the policy pair that
 24 is expected to result if the panel rules in favor of the complainant, where $W_c^0 < W_c^1$ and
 25 $W_d^0 > W_d^1$. We will begin by focusing on the case usually considered in the literature
 26 on settlement negotiation, where $D = W_c^1 - W_c^0 = W_d^0 - W_d^1$ is the amount of
 27 monetary damages that the defendant would be required to pay the complainant in the
 28 event of a settlement. Let $p_d(p_c)$ be the probability that the defendant (complainant)
 29 assigns to a win by the complainant and $c_d(c_c)$ the cost to the defendant (complainant)
 30 of litigating the case. The expected welfare gain of the complainant from proceeding
 31 with the complaint is $G(p_c) = p_c(W_c^1 - W_c^0) - c_c$ and the expected welfare loss of the
 32 defendant from proceeding is $L_d(p_d) = p_d(W_d^0 - W_d^1) + c_d$. In order for the complaint
 33 to be credible, it must satisfy $G(p_c) \geq 0$. If this condition fails, the defendant country
 34 will not negotiate because it will recognize that the complainant would be worse off
 35 by proceeding to the litigation stage.

40 ¹⁸ Shaffer (2003) reports that in the Photographic Film and Paper dispute initiated by the United States
 41 against Japan, these charges exceeded \$10 million and were paid by Kodak and Fuji.

42 ¹⁹ A defendant may also want to settle without going to trial in order to avoid the precedents set by the
 43 panel ruling, which may be used by other member countries to initiate new disputes in future. Moreover, in
 44 deciding on whether to pursue a contentious case, the big players in the WTO may also consider the effect
 of litigation on the evolution of the multilateral trading system. The latter case will be discussed below.

1 A successful outcome to the negotiations can arise if there exists a monetary trans-
 2 fer S satisfying
 3

$$4 L_d(p_d) = p_d D + c_d \geq S \geq G_c(p_c) = p_c D - c_c. \quad (2)$$

5 With common beliefs about the probability of a successful complaint (i.e. $p_c = p_d$),
 6 settlement should always occur prior to litigation in order to save the costs of litigation.
 7 If we assume that the outcome of the bargaining process is described by the Nash
 8 bargaining solution, the parties will split the gains from reaching an agreement. This
 9 yields an equilibrium transfer $S^N = pD + (c_d - c_c)/2$ and payoffs of $W_c^0 + S^N$ and
 10 $W_d^0 - S^N$. The party with higher litigation costs will be at a disadvantage in bargaining
 11 and thus will receive a lower payoff, even though litigation does not actually occur.
 12

13 The rules of the dispute settlement process will affect the distribution of payoffs
 14 between the complainant and the defendant, as well as the incentive of countries that
 15 believe they have been injured to file complaints. There are two aspects of the dispute
 16 settlement process that favor the defendant in the bargaining process. The first is that
 17 the WTO discourages unilateral retaliation on the part of the complainant. Retaliation
 18 during the consultation phase would raise W_c^0 and reduce W_d^0 , which would raise the
 19 net payoff to the complainant and reduce that to the defendant. It should be noted,
 20 however, that there is some question about the effectiveness of the WTO restraint
 21 against unilateral retaliation. Reinhardt (1999) found that when one country is the
 22 defendant in a WTO suit filed by a partner country in the previous year, the chances of
 23 the prior defendant filing a new dispute against that partner are increased by up to 51
 24 times. These ‘tit for tat’ filings could represent the defendants’ responses to retaliatory
 25 actions taken by the complaining countries or their attempts to impose costs on those
 26 countries. The second aspect of the DSU that is in favor of the defendants concerns
 27 the level of punishment that can be authorized by the panel. Successful complainants
 28 are limited to the withdrawal of equivalent concessions and cannot make punishments
 29 retroactive, both features that tend to reduce W_c^1 and raise W_d^1 .

30 This model also suggests that the strengthening of the rules under the WTO process
 31 should lead to a higher expected return to filing a complaint. The elimination of the
 32 unanimity requirement should raise the probability of success for the complainant,
 33 and any shortening of the panel process should raise the expected present value of a
 34 successful outcome. Since complainants will only file if the expected value is positive,
 35 these stronger rules would be expected to increase the frequency of complaints.

36 The model of settlement bargaining with symmetric information predicts that all
 37 disputes will be settled prior to going to a panel decision. However, we do observe
 38 that a significant fraction of the disputes – around 40 percent – end up with a panel
 39 decision. This proportion is actually much higher than that observed in domestic U.S.
 40 civil disputes, where only about five percent of cases go to trial. Therefore, it is useful
 41 to examine models that have the potential to explain why settlements do not occur prior
 42 to a panel decision. Models of bargaining between a plaintiff and defendant when there
 43 is asymmetric information have been developed in the law and economics literature to
 44 explain why some cases go to trial and others are settled out of court. Although these

models are not explicitly designed to analyze the dispute settlement process, they can provide insights about why settlement bargaining may fail.

Early models took a non-Bayesian approach to the settlement breakdown, in which the disputants may have different and possibly inconsistent priors about the outcome at trial. If either of the disputants is too optimistic about her chance to win at the trial, out-of-court negotiations could break down. Specifically, there will be values of (p_c, p_d) such that p_c is sufficiently high and p_d sufficiently low that the inequality in (2) fails and no settlement can occur.²⁰

4.2. Incomplete-information models

While the model with differing initial beliefs can generate a failure to settle, it is not very helpful in generating predictions about what types of cases are more likely to lead to breakdowns in settlement. Subsequent modeling has focused on the premise that information may be revealed as part of the bargaining process and this revelation could mitigate the inefficiencies caused by information asymmetry. According to the models of settlement bargaining under asymmetric information, the disputants may act strategically in offering and accepting settlement options in order to screen their partner's type or signal their own type. Under both signaling and screening models, a fraction of disputes fail to reach out-of-court settlement. We can illustrate this point using two of the canonical models of settlement bargaining under asymmetric information in which the complainant makes a settlement offer to the defendant. In the first model, due to Bebchuk (1984), the defendant has better information about the probability of a court decision and the offer is made by the uninformed party. In the second model, due to Reinganum and Wilde (1986), the complainant has better information about the size of the losses and the offer is made by the more informed party.²¹

Bebchuk (1984) assumes that the defendant knows the true probability of success of the complaint, p . The complainant is assumed to know that the likelihood of success is distributed according to a probability distribution, F , with support on the interval $[p_L, p_U]$. The size of the damages is common knowledge. It is assumed that the complainant makes a settlement demand, S . The defendant decides whether to accept the demand and settle the case without litigation, or to reject it and proceed to the court. From Equation (2), the defendant would accept S if and only if $S < L_d(p)$, which requires that $p > q(S) \equiv (S - c_d)/D$. The complainant country will then make an offer that maximizes its expected gain, which is the solution to

$$\max_s (1 - F(q(S)))S + \int_{p_L}^{q(S)} (Dp - C_c)f(p) dp. \quad (3)$$

²⁰ For more discussion of this approach and for bibliographical information see Spier (2005).

²¹ For a thorough review of the economic theories of the settlement bargaining see Daughety and Reinganum (2005) and Spier (2005).

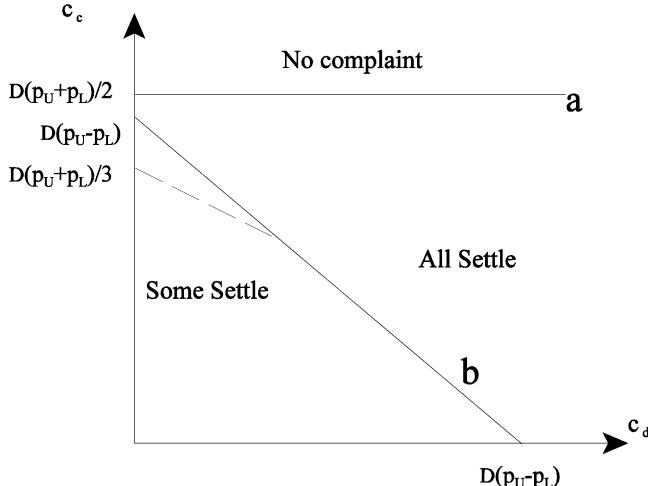


Fig. 2. Settlement pattern in the screening model.

An increase in the settlement demand will extract more from defendants when the true probability is low, but will reduce the probability that the defendant actually accepts the demand. Letting \tilde{s} denote an interior solution to (3), the equilibrium will be one in which all defendants with $p \geq q(\tilde{s})$ will settle, while those with $p < q(\tilde{s})$ will reject the settlement demand and wait for the panel decision. The equilibrium settlement is denoted $\tilde{r} = 1 - F(q(\tilde{s}))$. Generally, an injured party would file a complaint if and only if $c_c \leq D \int_{p_L}^{p_U} xf(x) dx$.²² It can be shown that for $c_c < p_L D$, an increase in the cost of litigation for either party or a reduction in the level of damages imposed will make settlement more likely. This result is intuitive as it implies that a dispute is escalated to the court only if the potential court award is so large that it becomes worthwhile to incur the costs of litigation.

Figure 2 illustrates how the outcome of settlement bargaining is affected by the level of litigation costs $\{c_c, c_d\}$ when p is uniformly distributed on $[p_L, p_U]$. For any values above the horizontal line, a , no complaint will be filed because the complainant's threat of litigation would not be credible. Thus, no defendant would be willing to settle a complaint. For values below a , a complaint will be filed. The line b is the locus of values of c_c and c_d at which the probability of settlement is unity. Settlement will always occur for values below a and to the right of b . The probability of settlement in the region to the left of b and below the dashed line is given by

²² Bebchuk imposes a restriction on the range of complainant costs to ensure that the complainant's threat of litigation is always credible. Specifically, he assumes $c_c < p_L D$, which is more restrictive than necessary, but it simplifies the analysis. Since we are also interested in the behavior of parties before filing a complaint, our description of the model considers the entire range of complainant's costs.

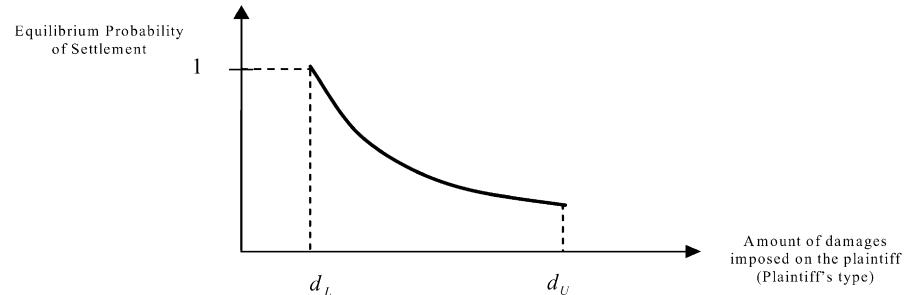


Fig. 3. *Equilibrium probability of settlement in the signaling model.*

$(c_c + c_d)/(D(p_U - p_L))$. This means that the probability of litigation occurring decreases in both litigation cost parameters. In the region bounded by b and the dashed line, the settlement rate is given by $(p_U + p_L - 2c_c/D)/(p_U - p_L)$. A mean-preserving spread of the distribution of p , which reflects an increase in the degree of informational asymmetry, would result in a rightward shift in line b . Therefore, the probability of settlement is weakly decreasing in the degree of uncertainty. Thus, more litigation occurs when the degree of uncertainty is greater.

In contrast to Bebchuk (1984), Reinganum and Wilde (1986) develop a model in which it is the informed party who proposes a settlement. Suppose the complainant country knows more about the level of damages to the domestic industry due to the alleged violation of the agreement than does the defendant. We model this by assuming that the level of damages D is known with certainty by the complainant, while the defendant only knows that D is drawn from a probability distribution G with support on the interval $[D_L, D_U]$. By proposing a settlement, the complainant country effectively signals the extent of damages it suffers. In the equilibrium the defendant adopts a mixed strategy as to whether to reject or accept the complainant's demand, conditional on the transmitted signal. The equilibrium probabilities are illustrated in Figure 3.

The screening and signaling models differ in that the former has a pure-strategy equilibrium, whereas the latter has a mixed-strategy equilibrium. However, the comparative statics of both models are similar in regard to the effect of litigation costs on the settlement rate. Therefore, the predictions of the two models concerning the relationships between country characteristics are similar.

4.3. Compensation methods: cash transfer versus policy adjustment

The discussions above have treated the negotiations between countries as if the damages and settlements represent cash transfers between countries. These cash transfers have two features that simplify the analysis of settlement bargaining. First, the bargaining between countries with cash transfers will be a zero-sum game because the monetary loss to one country will be of equal magnitude to the gain of the other.

1 Second, the cash transfers are divisible and can be treated as a continuous variable.
 2 In practice, the penalties imposed by panels and the settlements negotiated between
 3 countries almost always involve policy changes rather than cash transfers.²³ In this
 4 section we examine how the analysis would be modified in cases where the policy
 5 changes do not involve a zero-sum game between countries and where there may be
 6 indivisibilities in policy choice.

7 When damages and settlement negotiations are conducted in terms of policy
 8 changes, there is a presumption that the settlement and dispute process is a positive-
 9 sum game. If a complaint results from the deviation by one country from a negotiated
 10 value, then the initial bargaining position should be an efficient policy choice for the
 11 countries as noted above. In contrast, a deviation by one country will involve an ineffi-
 12 cient policy choice that benefits the deviator at the expense of the complaining country.
 13 If the penalty imposed by the panel is a return to the initial negotiated policy pair, then
 14 the efficiency of the initial policy choice will mean that the gains to the complainant,
 15 $W_c^1 - W_c^0$, exceed the losses to the defendant, $W_d^0 - W_d^1$. In order for a settlement to be
 16 satisfactory to both parties, it must provide payoffs (W_d^S, W_c^S) to the respective parties
 17 such that $W_d^S \geq W_d^0 - L(p_d)$ and $W_c^S \geq W_c^0 + G(p_c)$.

18 When settlements are made by negotiating policy changes between countries,
 19 we can summarize the possible payoffs for the countries by the settlement frontier
 20 $W_d = \varphi(W_c)$ that indicates the maximum settlement payoff for the deviating country
 21 as a function of the settlement welfare obtained by the complaining country. Clearly
 22 $W_d^i \leq \varphi(W_c^i)$ for $i = 0, 1$ since the initial policy and settlement choices are known
 23 to be feasible. Since the expected payoff pair $\{W_d^0 - L(p), W_c^0 + G(p)\}$ from litiga-
 24 tion is strictly less than $\{pW_c^1 + (1-p)W_c^0, pW_d^1 + (1-p)W_d^0\}$ when $c_c, c_d > 0$,
 25 it follows that a sufficient condition for a settlement to exist with $p_c = p_d$ is that
 26 the settlement frontier be a continuous and concave function. This is clearly satisfied
 27 in the case of monetary transfers considered above, where the settlement frontier is
 28 $W_d = W_c^0 + W_d^0 - W_c$. If policy choices are divisible and can be treated as continuous
 29 variables, then the settlement process may yield efficiency gains for the two countries
 30 by allowing choice of more efficient policies. Thus, the assumption of a continuous
 31 and concave settlement function seems plausible in this case.

32 This result shows that with continuous policy choices, the fact that compensation
 33 occurs in the form of policy choices rather than cash transfers does not alter the con-
 34 clusion that settlement should always be reached when the countries have the same
 35 beliefs about the probability of a successful complaint. However, as Guzman and
 36 Simmons (2002) point out, if the subject matter of the dispute has an all-or-nothing
 37 character (e.g., disputes over health and safety regulations) and leaves little room for
 38 compromise, the parties' ability to reach an agreement through policy adjustments

40
 41
 42²³ As discussed earlier, so-called Bars and Grills dispute between the United States and EU was an ex-
 43 ception, with the former country agreed to pay \$3.3 million as compensation for impairing the benefits of
 44 European music right holders from the TRIPS agreement during the three-year period 1996–1998.

is restricted. When monetary transfers are impractical, lumpiness of the subject matter of the dispute can lead to litigation even if the disputants share all the available knowledge relevant to the case.²⁴ Consider for example the extreme case in which the only two possible outcomes for the country are to remain with the current policy or to choose the policy that will ultimately be imposed by the panel if it supports the complaint. The only circumstance under which the defendant would be willing to settle in this case is that if c_c and p are sufficiently high that $(1 - p)(W_d^0 - W_d^1) < c_d$.

4.4. Political and institutional considerations

Under the above models, an inefficient outcome of the settlement-bargaining process is due to imperfect information. We also discussed the inefficiency that may arise from the restricted means of compensation in Section 4.3. But there are still other sources of inefficiency that seem to be important in the context of the international trading system. We discuss some of these problems that have been analyzed in the literature.

4.4.1. Signaling to domestic interest groups

Domestic politics may provide an alternative explanation for prevalence of litigation in the WTO. In dealing with trade disputes, governments are under pressure from their domestic interest groups such that any concession during the consultations may be associated with high political costs. As Davis (2006, p. 226) has put it, “... governments need a justification to give their domestic regulatory agency and lobby groups before they can change policies that were adopted to protect sensitive sectors.” By bringing a case before the dispute panel and obtaining official rulings of the WTO, a government can diffuse the political pressure from the interest groups by appealing to its international obligations. This explanation is more in line with the view of trade agreements as commitment mechanisms which are used to offset the bargaining power of local interest groups. Interestingly, as reported by Busch (2000) and Guzman and Simmons (2002), democratic governments, which are naturally under more influence from their domestic interest groups, are less likely to settle a dispute in the consultation stage.

4.4.2. DSU rules

Prevalence of late-stage settlements might also be a consequence of the DSU rules. Whereas any unilateral retaliation by a complaining country is discouraged by the DSU, an offending country is not held liable for the past injury imposed on the complainant and will not suffer a sanction if it discontinues the disputed action. That is, the DSU effectively allows an offending party to enjoy a period of time in violation of its obligations without any punishment. This may encourage some member countries to violate their obligations and then drag their feet along different stages of the

²⁴ In Butler and Hauser (2000), which is a complete information model of dispute settlement process, the lumpiness of the transfers between the disputants drives the results regarding the timing of settlement.

1 DSP and finally correct their actions just before retaliation is authorized. However,
2 the offended country may opt for unauthorized retaliation in order to deter the off-
3 fending country from feet-dragging in the negotiation process. The fact that so many
4 tit-for-tat disputes are filed in the WTO²⁵ supports the view that, during the negotia-
5 tion process, complainants retaliate against responding parties by suspending some of
6 the previously-granted market access.²⁶

7 Moreover, the DSU rule that allows third parties to join a WTO dispute may have
8 bearings on the prospect of early settlements. As was explained above, most of the
9 models of settlement bargaining predict a lower settlement rate for cases involving
10 larger stake. Therefore, the engagement of third parties in the dispute, by raising the
11 responding country's loss from a concession, can increase that country's incentive to
12 go to trial. Involvement of third parties can further undermine the prospect of out-of-
13 court settlement, as it is more costly and time-consuming to negotiate a settlement
14 with several complainants. In Busch and Reinhardt (2006), empirical analysis of this
15 issue implies that a single-complainant dispute with a 50-percent chance of settlement
16 would only have a 16-percent chance of settlement if at least one third party joins the
17 dispute.

18 In deciding whether to pursue a contentious case, the largest countries in the WTO
19 may also consider the effect of litigation on the evolution of the multilateral trading
20 system. Garrett and Smith (2002) point out that the United States and the EU have
21 on occasion decided not to push contentious disputes through the WTO system for
22 fear of de-legitimizing it. For example, they discuss the EU's decision to withdraw its
23 complaint against the U.S. Helms–Burton Act, and conclude (p. 3) that "the EU sus-
24 pended the proceedings because it did not want to put WTO arbitrators in an invidious
25 situation that inevitably would have damaged the DSU. A decision for the U.S. would
26 have been difficult to justify on legal grounds, whereas Washington openly threatened
27 to defy any ruling against it.... [In such situations] the complainant may prefer to
28 settle if it believes the defendant is unlikely to comply and hence that the only conse-
29 quence of keeping the case on the WTO agenda will be to undermine the authority of
30 the DSU."

31 Developing countries may pursue other goals by engaging in WTO disputes as
32 third parties. Participating in dispute settlement cases as a third party or jointly filing a
33 case along with other more experienced WTO members can represent an easy window
34 into learning how the system works, permitting governments to improve their legal
35 capacity for future disputes.²⁷ In fact, China has adopted this strategy and frequently
36 joins cases as a third party.

37
38

39 ²⁵ Klimenko *et al.* (2006) and Reinhardt (1999) document the widespread use of tit-for-tat disputes. Further,
40 according to Prusa (1999), two-thirds of all antidumping complaints are tit-for-tat responses to antidumping
41 actions of other countries.

42 ²⁶ Sometimes, tit-for-tat disputes resemble frivolous law suits, which may be a strategic move by the defen-
43 dant to impose more costs on the complainant from pursuing the original dispute.

44 ²⁷ This idea has been expressed by Christina Davis in an interview with *The Viet Nam News*, <http://vietnamnews.vnagency.com.vn/showarticle.php?num=02COM220706>.

1 **4.5. Developing countries and the dispute settlement process**

2

3 One of the complaints that has often been raised about the WTO dispute settlement
4 process is that developing countries are at a disadvantage because they have high costs
5 of litigation. High litigation costs could disadvantage smaller and poorer countries
6 in two ways. First, these countries tend to have smaller trade stakes, both overall
7 and in individual commodities, which makes it less profitable to absorb the litiga-
8 tion costs of pressing charges against countries that maintain illegal trade measures
9 (Nordström, 2005). Second, because of their poor legal capacity, developing countries
10 face higher marginal costs in WTO lawsuits. Greater legal capacity lets developed
11 countries maintain teams of legal and economic experts responsible for gathering and
12 analyzing evidence to detect potential infringements and to defend against potential
13 complaints. Bown (2005) presents evidence in support of both of these views. He has
14 found that while the size of exports at stake is an important determinant of a coun-
15 try's decision to challenge a deviating country, its retaliatory and legal capacity and its
16 international political economy relationships also matter.²⁸

17 According to settlement-bargaining models with asymmetric information (pre-
18 sented in the previous sections), higher litigation costs should result in higher rate
19 of early settlement. Therefore, if poorer countries have higher relative litigation costs,
20 those models predict higher settlement rates for dispute cases involving them. Thus,
21 a dispute between the United States and the EU is less likely to settle than a dispute be-
22 tween the United States and Argentina, and both are less likely to settle than a dispute
23 between Argentina and Chile.

24 Empirical observations provided by Beshkar (2006) support this hypothesis. He
25 shows that the likelihood of early settlement under DSP is inversely correlated with
26 the GDP and GDP per capita of both disputants. However, in contrast with the pre-
27 dictions of settlement-bargaining models, the likelihood of settlement in the WTO is
28 significantly more sensitive to the defendant's wealth than to the complainant's wealth.
29 Beshkar (2006) extends these models with asymmetric information to situations where
30 the relationship between the two countries is characterized by a Prisoner's Dilemma.
31 This makes the line *b* in Figure 2 steeper. Under the modified models the perceived
32 litigation costs of the defendant are higher than they actually are. Therefore, small
33 changes in the defendant's actual costs would have a pronounced effect on the like-
34 lihood of early settlement. For example, in a dispute between the United States and
35 Argentina, it matters who is the defendant and who is the complainant.

36 The prospect of costly negotiations and lack of human capital may deter develop-
37 ing countries from filing disputes that are otherwise worth pursuing. In practice, larger
38 trading nations have been far more active in using the WTO dispute settlement process

40 28 In order to help developing countries improve their participation in the multilateral trading system, the
41 Advisory Centre on WTO Law (ACWL) was established in 2001 and provides developing countries access
42 to legal aid for an hourly charge that ranges from \$25 for the least developed countries to \$200 for the
43 highest income developing countries (see <http://www.ACWL.ch>). Regarding implementation of the TRIPS
44 agreement, similar assistance is provided by the World Intellectual Property Organization.

than smaller and poorer nations. Horn *et al.* (1999) argue that this dominance might be a reflection of the fact that larger countries encounter more questionable trade-related measures than smaller ones. Large countries tend to have wider export varieties, a situation that translates into a larger number of disputable trade measures. Assigning a fixed probability of dispute to each exporting product, a country's frequency of filing complaints will be given by a binomial distribution function with the distribution parameter being the number of exporting products. Using data on export varieties of the WTO members and the dispute settlement data from the first four years of the DSU, they tentatively conclude that the seeming under-representation of developing countries, reflects their low diversity and value of trade.

5. Conclusions

In this chapter we have presented the state of the literature on dispute settlement and its relation to the protection of intellectual property. We conclude with some remarks on what seem to be promising areas for future research. First, the application of models of incomplete contracts to the analysis of dispute settlement is in its early stages and shows promise. These models suggest a role for the dispute settlement procedure for introducing flexibility into trade agreements under situations where there are policy adjustments with the potential to benefit both parties. It would be useful in this modeling to draw a distinction between the DSP and the safeguards system, which allows for adjustments to agreements in response to events that unduly harm domestic industries. When should flexibility be introduced through these rules as opposed to through the DSP? In particular, it is unclear why the DSU seems to discourage countries from "buying" adjustments in their tariffs in return for the withdrawal of equivalent concessions. Also, it would be useful to consider models of incomplete contracts that incorporate the requirement that agreements be self-enforcing.

A second point concerns the role of multilateralism in the DSP. Most of the models of the DSP involve just two countries. However, the fact that unilateral retaliatory actions are discouraged suggests that the WTO is concerned about their potential spillover effects to the trading system. Since unilateral retaliation could be accomplished more quickly than waiting for cases to work through the DSP, the deterrence benefits it would imply must be offset by negative effects on the stability of the trading system. It would be useful to have models that incorporated this spillover.

Uncited references

(Horn and Mavroidis, 2001)

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